

IN SITU MAPPING OF THE ORGANIC MATTER IN CARBONACEOUS CHONDRITES AND MINERAL RELATIONSHIPS.

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Introduction: Carbonaceous chondrite organic matter represents a fossil record of reactions that occurred in a range of physically, spatially and temporally distinct environments, from the interstellar medium to asteroid parent bodies. While bulk chemical analysis has provided a detailed view of the nature and diversity of this organic matter [1], almost nothing is known about its spatial distribution and mineralogical relationships (although see: [2-3]). Such information is nevertheless critical to deciphering its formation processes and evolutionary history.

Approach & Technique: We have developed a microprobe two-step laser desorption photoionization mass spectrometer (μ -L²MS) [4] to map the distribution of organic species *in situ* at the micron scale. Here we report organic analyses of the Tagish Lake (C-ungrouped), Bells (CM2), Murchison (CM2) and Vigarano (CV3) carbonaceous chondrites. Our μ -L²MS instrument has previously been restricted to measuring aromatic hydrocarbons (PAHs). We have now overcome this limitation by using a vacuum ultraviolet (VUV) laser ionization source capable of non-resonant single-photon soft ionization of essentially *all organic species*. We obtained organic maps up to ~1000 amu from freshly fractured meteorite surfaces. The samples were later Pt-coated and their mineral and elemental compositions determined by field-emission SEM and EDX mapping.

Results & Discussion: We observed a broad range of organic species within the meteorite matrix. Individual molecular species and species of different functionalities (*e.g.*, non-polar *R-H* vs. polar *R-OH/R-SH*) were heterogeneous on 10's to 100's of μ m scales. We did not observe chemical associations with individual mineral grains, suggesting that some molecules were mobilized by aqueous fluids during parent body alteration (*e.g.*, [5]). We also observed organic 'hot-spots' in Tagish Lake and Murchison that were subsequently determined to be organic nanoglobules [6]. The organic globules are chemically similar to average matrix but are enriched in high mass organic species. Vigarano organic 'hot-spots' were also identified as fine-grained carbonaceous coatings on olivine grains. We also observed evidence that organic matter is concentrated in fine-grained phyllosilicate rims. Further studies will reveal the relationships between the formation and evolution of asteroidal mineralogy and organic matter.

References: [1] Pizzarello et al. 2006. *Meteorites and the Early Solar System II*, 625-651; [2] Pearson et al. 2002. *MAPS* **37**, 1829-1833; [3] Kebukawa et al. 2010. *MAPS* **45**, 394-405 [4] Clemett & Zare 1997. *IAUS* **178**, 305-320; [5] Wing & Bada 1991. *GCA* **55**, 2937-2942; [6] Nakamura-Messenger et al. 2006. *Science* **314**:1439-1442.